

# Non-technological innovation activities mediate the impacts of the intra- and extra-organizational contexts on technological innovation outputs <sup>1</sup>

**Ana Ferreira** ([aferreira@fcsh.unl.pt](mailto:aferreira@fcsh.unl.pt)), Centro Interdisciplinar de Ciências Sociais CICS.NOVA, Faculdade de Ciências Sociais e Humanas - Universidade Nova de Lisboa, Portugal

**Ana Lúcia Teixeira** ([analuciateixeira@fcsh.unl.pt](mailto:analuciateixeira@fcsh.unl.pt)), Centro Interdisciplinar de Ciências Sociais CICS.NOVA, Faculdade de Ciências Sociais e Humanas - Universidade Nova de Lisboa, Portugal

**Ana Roque Dantas** ([ana.roque@fcsh.unl.pt](mailto:ana.roque@fcsh.unl.pt)), Centro Interdisciplinar de Ciências Sociais CICS.NOVA, Faculdade de Ciências Sociais e Humanas - Universidade Nova de Lisboa, Portugal

## Abstract

The increasing interest on innovation studies and, particularly, on technological innovation has been attributed to innovation's social and economic relevance. Still, organizational and marketing innovation activities, which are critical for firms' economic performance, have been far less studied. This paper will specifically characterize these non-technological innovation processes, their firm and environmental underpinnings, as well as their impacts on technological innovation outputs (i.e., goods and services). For this purpose, it focuses on the Information and Communication Technology (ICT) services sector in Portugal between 2010 and 2012. This period is characterized by a socio-economic crisis context that is concomitant to decreases in firms' innovation activities and economic performance. Under this challenging scenario, our data shows that organizational and/or marketing innovation activities mediate the impacts of firms' 1) assets; 2) research activities and empowerment strategies; and 3) structure and climate of decision-making processes, on technological innovation outputs. This study reveals that decreases in innovative performance during the socio-economic crisis could be

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attributed not only to unfavourable firm and environmental contexts, but also to the absence of non-technological innovation activities. As such, it is suggested that support of non-technological innovation by firms' managers and, at a broader level, by public policies is critical for launching of new products and services to the markets.

**Key-words:** Organizational innovation; Marketing innovation; Crisis; ICT services sector

**JEL codes:** A14, D2, L8, O3

## Introduction

During the last decades, the study of innovation processes has been taking broad attention from the scientific community. This attention was argued to be linked to the social and economic impacts of innovation development. However, different types of innovation activities have not been enjoying similar scientific scrutiny. In fact, most research has been focusing on technological innovation activities (encompassing product and process innovation activities) rather than on non-technological innovation activities (involving organizational and marketing innovation activities) (OECD and Eurostat, 2005). It is precisely on these less studied non-technological innovation processes that this paper focuses on. More specifically, it will characterize organizational and marketing innovation activities and their firm and environmental contexts in the critical period between 2010 and 2012, in Portugal. This has not been previously addressed.

In fact, in 2010, the year in which the sovereign debt crisis burst in Europe, the frequency of innovation activities in Portugal inverted the increasing trend that characterized it during the first decade of the 21<sup>st</sup> century (European Commission, 2014). This decreasing pattern followed a reduction in firms' willingness to innovate (Archibugi & Filippetti, 2013), and is revealed both at the level of technological and non-technological innovation activities after 2010 (European Commission, 2014). More precisely, the frequency of technological innovation activities decreased from 46.6% in 2008-2010 to 41.2% in 2010-2012; organizational innovation (i.e., application of new procedures concerning business practices; workplace organization and/or external relations) decreased from 36.1% to 33.0%; and marketing innovation (i.e., application of new marketing practices encompassing substantial alterations on design; packaging; placement; promotion or pricing of products) decreased from 34.5% to 32.6% (European Commission,

2014).

These trends were also present at the most innovative sector of economic activities in Portugal, i.e., the Information and Communication Technology (ICT) services sector, in which this paper focuses on. ICT services firms presented decreases in technological innovation activities from 80.6% in 2008-2010 to 71.1% in 2010-2012; in organizational innovation activities from 66.0% to 59.8%; and in marketing innovation activities from 59.0% to 57.4% (European Commission, 2014). In fact, despite this sector presenting the highest investments in research and development (R&D) and innovation, as well as the highest outputs of innovation to both internal and external markets among all sectors of economic activities in Portugal between 2010 and 2012, decreases in both technological and non-technological innovation were still very much pronounced. This is a rather problematic scenario considering 1) the widely reported role of technological innovation in firms' economic performance (Akgün, Keskin, Byrne, & Aren, 2007; Cefis & Marsili, 2006; García-Morales, Lloréns-Montes, & Verdú-Jover, 2007; Mansury & Love, 2008; Rosenbusch, Brinckmann, & Bausch, 2011; Savona, Cainelli, & Evangelista, 2004), and 2) the relevance of non-technological innovation either for firms' performance (Camisón & Villar-López, 2014; Gera & Gu, 2004; Mol & Birkinshaw, 2009) or for successfully placing new goods or services in the markets (Cozzarin & Percival, 2006; Griffin & Hauser, 1996; Sawhney, Wolcott, & Arroniz, 2006). These results point to interconnections between these two broad innovation categories.

In fact, links between technological and non-technological innovation activities have been confirmed in studies addressing the concomitant development of these types of innovation and showing associations with firms' growth (Morone & Testa, 2008) and performance (Filippetti, 2011; Han, Kim, & Srivastava, 1998). Still, with few exceptions (Battisti & Stoneman, 2010; Filippetti, 2011; Le Bas, Mothe, & Nguyen-Thi, 2015; Mothe & Nguyen Thi, 2010), studies have neither systematically addressed these relations, nor the impacts of organizational or marketing innovation activities on technological innovation activities.

A similar scenario is present in Portugal, where it was previously shown that both types of innovation coexist in diverse sectors of economic activities (Barañano, 2005; Dinis, 2006; European Commission, 2014; Inhan, Ferreira, Marques, & Rebelo, 2013). Nevertheless, a lack of knowledge in how organizational and marketing innovation relates to product and process innovation activities persists. This paper also aims to contribute to this literature. For this purpose we will assess the impacts of non-technological innovation activities on technological innovation outputs (e.g., goods; services) at the highly innovative ICT services sector between 2010 and 2012.

During these years, ICT services firms operating in Portugal presented

negative economic performance. This is revealed by decreased annual turnovers since 2008 and, since 2010, decreased production values, gross value added, gross operating surplus, assets, liabilities, equity capital, and gross investments in tangible goods (INE, 2014). This picture of the ICT services sector, along with the above presented sketch of its innovation activities, cannot be isolated from the socio-economic crisis and changing political context in which Portugal was submerged. In summary, the problem this paper addresses is whether the development of non-technological innovation is critical for the production of technological innovation outputs under a socio-economic crisis that strongly impacted on firms' economic performance. The socio-economic crisis context and its possible impacts on innovation are discussed in the next section.

## Innovation during the socio-economic crisis

Upon the outbreak of the global financial crisis in 2007-2008, Portugal was already characterized by a fragile economic growth, increasing unemployment rates, high public deficit and external debt. Rather than a recent scenario in Portugal, this socio-economic context has been argued to result from long-lasting structural weaknesses (low level of education; economic specialization based on low value added and low tech activities; peripheral geographic positioning of the Portuguese economy), and continuous exposure to external shocks (e.g., increase in European Central Bank interests rates; peak prices of oil and commodities; appreciation of the Euro; restrictive fiscal policies) without the adequate financial and economic instruments to face them (Mamede, 2012). In fact, the policy measures implemented by the different Portuguese governments to face up against the 2007-2008 global financial crisis and its repercussions were totally in line with EU's strategies: firstly, with policies aiming at compensating for the credit crunch and warrant sustainability to the financial sector (2008)<sup>2</sup>; secondly, with policies aiming at alleviating the economic and social impacts of the crisis; and finally, with the imposition of austerity measures via the *Programa de Estabilidade e Crescimento*<sup>3</sup> and the signature of the *Memorandum of Understanding* with the European Central Bank, European

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<sup>2</sup> This first line of measures was implemented under a Socialist party majority ruling (Group of the Progressive Alliance of Socialists and Democrats in the European Parliament).

<sup>3</sup> These policies were implemented by a minority Socialist party government.

Commission, and International Monetary Fund<sup>4</sup> (Pedroso, 2014). Despite all these programs and associated measures, between 2010 and 2012, while public debt and unemployment continued to increase, severe decreases were present in GDP growth; the rate of change in gross value added by all sectors of economic activities; and R&D expenditures in all sectors of performance (European Commission, 2015; OECD, 2015). This is precisely the period that this paper focuses on, a period in which, to the best of our knowledge, the development of organizational and marketing innovation activities, their underlying firm and environmental contexts, and their impact on technological innovation outputs of ICT services firms, have not been studied in Portugal.

At the European level, decreasing trends in innovation activities were present in the period between 2010 and 2012 (European Commission, 2014). More specifically, a study comparing Community Innovation Survey data collected in the UK before (2004 and 2006) and during (2008) the crisis showed that the economic crisis prompted the concentration of innovation in firms that were previously developing innovation activities and in fast-growing new firms. Additionally, companies developing non-technological innovation activities were in a more favourable position to face the economic crisis (Archibugi, Filippetti, & Frenz, 2013). The same study further revealed that during the economic crisis (i.e., in 2008), innovation expenditures were not associated with firms' size and economic performance, but rather with the presence of in-house R&D and the mobilization of explorative strategies, particularly those targeting new markets and new product development (Archibugi et al., 2013). Other studies, addressing innovation during the global financial crisis outbreak and its repercussions (namely a study conducted between 2007 and 2010), revealed that the implementation of new organizational practices mediated the impacts of product innovation outputs on companies' sales (Makkonen, Pohjola, Olkkonen, & Koponen, 2014). These results suggest that, even during the global financial crisis, companies developing non-technological innovation activities were better positioned to cope with the challenging economic scenario in which they were submerged. But which companies developed organizational and/or marketing innovation activities in Portugal between 2010 and 2012? In which organizational and environmental settings did they operate? And, more specifically, which were the "critical inputs" for the development of these innovation activities? The next section will precisely focus on the foundations of non-technological innovation processes.

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<sup>4</sup> These measures were implemented under the ruling of a coalition government integrating Partido Social Democrata and Partido Popular (members of the European People's Party in the European Parliament).

## The foundations of organizational and marketing innovation activities

The development of non-technological innovation activities was previously shown to be associated with the intra- and extra-organizational contexts in which firms' operate (*reviewed in* (Crossan & Apaydin, 2010; Frambach & Schillewaert, 2002)). In fact, previous studies addressed the associations between non-technological innovation and firms' size, structure, and sector of economic activity (Cohn & Turyn, 1984; Damanpour, 1991, 1992; Mol & Birkinshaw, 2009; Nunes, 2012; Wan, Ong, & Lee, 2005); companies' culture, management strategies, and practices (Daft, 1978; Damanpour, 1987; Damanpour & Schneider, 2006; Filippetti, 2011; Han et al., 1998; Moreira, Silva, & Simões, 2012; Sarros, Cooper, & Santora, 2008; Wan et al., 2005); functional assets, including human resources (Damanpour, 1991; Mol & Birkinshaw, 2009) and communication (Damanpour, 1991; Damanpour & Schneider, 2006); and partners, suppliers, clients, and/or competitors (Damanpour, 1991; Damanpour & Schneider, 2006; Filippetti, 2011; Mol & Birkinshaw, 2009).

More specifically, while most studies revealed that the development of non-technological innovation was associated with companies' size (in the Portuguese context, organizational innovation activities were also shown to be dependent on companies' size (Nunes, 2012)), divergent results were also reported. A meta-analysis of scientific literature indicated that, while there is a statistically significant positive relation between size and non-technological innovation, this relation is moderated by the type of organization (e.g., manufacturing; services); scope of innovation (high *versus* low); and stage of innovation adoption (initiation *versus* implementation). Moreover, the same study revealed that methodological differences in the assessment of companies' size can also account for the differences found in previous studies (Damanpour, 1992).

In what concerns companies' culture, previous studies revealed that the adoption and/or implementation of non-technological innovation is favoured by 1) a culture of change/willingness to take risks (Damanpour & Schneider, 2006; Wan et al., 2005); 2) positive perceptions on innovation in general (Wan et al., 2005) and, particularly, perceptions on the adoption and usage of the specific innovation procedure at stake (Tornatzky & Klein, 1982); and 3) openness to exchange ideas (Wan et al., 2005). Also, 4) a competitive, performance-oriented organizational culture is positively related to favourable

climate for organizational innovation (Sarros et al., 2008); and 5) companies with a market-oriented culture present higher levels of organizational innovation and economic performance (Han et al., 1998).

In addition, management strategies and practices, such as training, education, technical support, or any activities that ease the implementation of a specific innovation, were shown to drive non-technological innovation activities (Daft, 1978; Damanpour, 1987; Moreira et al., 2012). In these lines, at the European level and for a cluster of multifaceted innovative firms that develop both technological and non-technological innovation, marketing and organizational innovation were associated with both R&D and design activities (Filippetti, 2011). In Portugal (2002 – 2004), marketing innovation activities were dependent on the internal development of R&D and marketing activities; the acquisition of machinery, equipment and software; the acquisition of other types of external knowledge, as well as on the implementation of other procedures that ease innovation development and implementation (Moreira et al., 2012). As for the previously reported drivers of non-technological innovation, the presence of highly skilled human resources guaranteeing a broad knowledge base, is a surplus for the adoption and implementation of all types of innovation activities (Damanpour, 1991) and, particularly, for non-technological innovation (Mol & Birkinshaw, 2009). A similar type of relation is also present when assessing the impacts of internal and external communication on organizational innovation (*reviewed in* (Damanpour, 1991)). More specifically, it is argued that while effective internal communication allows for the dispersion of new ideas, their implementation and effective maintenance, external communication enables for continuous scanning of environments for new solutions favouring an increased firms' performance.

Finally, studies have previously reported that the adoption of specific organizational and/or marketing innovative procedures by firms' suppliers, partners, clients and competitors favours innovation adoption and implementation (Han et al., 1998; Hultink, Griffin, Hart, & Robben, 1997; Robertson & Gatignon, 1986). More recently, a study conducted by Mol and Birkinshaw revealed that internal and external professional networks, as well as firms' clients, competitors and consultants, being critical sources of new ideas, have favourable impacts on the introduction of non-technological innovation (Mol & Birkinshaw, 2009). Moreover, the higher the degree of firms' interconnectedness, the more likely firms are to be exposed to new information and to implement innovative organizational and/or marketing strategies (Lind & Zmud, 1991; Rogers, 2010).

If these studies characterized the role of specific drivers and blockers of organizational and marketing innovation, they also have, with few exceptions, focused on the disaggregated analysis of these dimensions, without addressing whether these factors simultaneously contribute for the development of non-technological innovation. As such, and going beyond

previous literature, we now aim to assess the simultaneous internal and external foundations of non-technological innovation, as well as to characterize the type of ICT services firms that implement them the most. In fact, few studies have addressed the foundations of organizational and/or marketing innovation activities in Portugal (Moreira et al., 2012; Nunes, 2012) and, to the best of our knowledge, none has addressed these processes at the ICT services sector during the 2010-2012 socio-economic crisis period. As such, this study will also contribute to the growth of this stream of research in the Portuguese academia.

Based on the previous literature review, we next present the aims and hypotheses of this study. This is followed by the methodological approach and, subsequently, the results. The last section of this paper discusses our data, presents the limitations of our study, and proposes future potential studies. The paper finalizes with concluding remarks.

## Aims and hypotheses

At a first level, this study characterizes non-technological innovation activities, i.e., organizational and marketing innovation activities and their subtypes, as well as their firm and/or environmental underpinnings. These will be addressed via the following indicators: evolution of financial resources; human resources; internal bureaucratic structures and procedures; management of human resources; knowledge-management; planning and monitoring of projects; discussion for strategic decision-making; pressure on strategic decision-making; R&D; creativity stimuli; networks; formal internal and external communication; networks; internationalization; employees' motivation; employees' autonomy; trust in employees; suppliers; clients; competitors; external bureaucracy (e.g., government regulations and legislation). At this stage, the following hypotheses will be tested:

**Hypothesis 1.** Between 2010 and 2012, the development of non-technological innovation activities by ICT services firms operating in Portugal is simultaneously dependent on firms' intra- and extra-organizational contexts.



This is supported by the above-mentioned studies reporting that non-technological innovation activities are associated with 1) firms' structure (Cohn & Turyn, 1984; Damanpour, 1991, 1992; Wan et al., 2005); 2) companies' culture, management strategies, and practices (Daft, 1978; Damanpour, 1987; Damanpour & Schneider, 2006; Filippetti, 2011; Han et al., 1998; Moreira et al., 2012; Sarros et al., 2008; Wan et al., 2005); 3) functional assets, including human resources (Damanpour, 1991; Mol & Birkinshaw, 2009) and communication (Damanpour, 1991; Damanpour & Schneider, 2006); and 4) partners, suppliers, clients and/or competitors (Damanpour & Schneider, 2006; Filippetti, 2011; Han et al., 1998; Robertson & Gatignon, 1986). However, no studies have addressed the simultaneous impact of these dimensions on non-technological innovation activities in ICT services firms operating in Portugal between 2010 and 2012. As such, we will address this issue in the following sections of the current paper.

At a second level, this study characterizes the relations between non-technological innovation activities and technological innovation outputs (i.e., development of goods and services) between 2010 and 2012 at firms of the ICT services sector operating in Portugal. For this purpose the following hypothesis will be tested:

**Hypothesis 2.** Between 2010 and 2012, ICT services firms developing non-technological innovation activities in Portugal present increased technological innovation outputs.

This hypothesis is supported by the previously reported studies showing 1) the concomitant presence of technological and non-technological innovation activities (Barañano, 2005; Dinis, 2006; European Commission, 2014; Filippetti, 2011; Han et al., 1998; Inhan et al., 2013; Morone & Testa, 2008); 2) that both organizational and marketing innovation activities are associated with increased propensity to develop technological innovations (Battisti & Stoneman, 2010; Mothe & Nguyen Thi, 2010); 3) that non-technological innovation activities are critical for placing new goods or services in the markets (Cozzarin & Percival, 2006; Griffin & Hauser, 1996; Sawhney et al., 2006); 4) that organizational innovation is associated with increased technological innovation persistence, i.e., consecutive years in which firms present innovation outputs (Le Bas et al., 2015); and 5) that the implementation of new organizational practices favoured technological innovation outputs during the global financial crisis (Makkonen et al., 2014). However, to the best of our knowledge, no studies have addressed the impacts of organizational and/or marketing innovation activities on innovation outputs of ICT services firms during the socio-economic crisis in Portugal. This paper will cover this path assessing whether the development of goods and services depends on non-technological innovation activities.

Finally, this study characterizes the relations between the intra- and extra-organizational contexts, non-technological innovation activities, and technological innovation outputs. The following hypothesis will be tested:

**Hypothesis 3.** Between 2010 and 2012, non-technological innovation activities mediate the impact of firms' intra- and extra-organizational contexts on innovation outputs.

This hypothesis is supported by numerous studies suggesting the organizational and environmental underpinnings of technological innovation activities (*reviewed in* (Becheikh, Landry, & Amara, 2006; Gupta, Tesluk, & Taylor, 2007; Souitaris, 2002)), with several studies focusing on the Portuguese context (de Faria, Lima, & Santos, 2010; Lisboa, 2001; Nunes, 2012; Oliveira & Carvalho, 2010; Salavisa & Fontes, 2012). Also, this hypothesis draws upon studies revealing the internal and external foundations of non-technological innovation (*reviewed in* (Crossan & Apaydin, 2010; Frambach & Schillewaert, 2002)), again with studies addressing the Portuguese case (Moreira et al., 2012; Nunes, 2012). In addition, studies showing the role of non-technological innovation activities for placing innovation outputs in the markets (Cozzarin & Percival, 2006; Griffin & Hauser, 1996; Makkonen et al., 2014; Sawhney et al., 2006) are also supportive of this hypothesis. Despite the wide literature on this topic, no studies have addressed whether, under the socio-economic crisis context in Portugal, non-technological innovation activities mediate the impact of ICT services firms' internal and external contexts on innovation outputs. This study addresses this issue.

## Methods

The current paper is part of a broader research project on innovation development in companies of the ICT services sector (Section J, divisions 61 to 63) that operate in Portugal (European Commission, 2008; Ferreira, 2016; Ferreira & Teixeira, 2016). It specifically focuses on the characterization of non-technological, organizational, and marketing innovation activities, their internal and external drivers and blockers, and their impacts on technological innovation outputs.

The presented data was collected online during 2013. The survey was

answered by 309 ICT services firms' top managers. In order to have a proportional sample distribution regarding the universe of ICT services firms operating in Portugal in terms of classes of persons employed (INE, 2011)<sup>5</sup>, we have followed a quota sampling methodology. The main sample is also representative of the Portuguese ICT services sector in terms of the development of innovation activities (95% confidence interval; 5% maximum error of estimate) (European Commission, 2014).

Targeting the period between 2010 and 2012, the survey included several dimensions, namely those related to the current discussion, and that will be next presented. It starts with a general characterization of the companies via an evaluation of the following variables: A) classes of persons employed; annual turnover; and incorporation date. Secondly, it addresses B) innovation activities (in general); product innovation; process innovation; organizational innovation and its subtypes (i.e., procedures; decision-making processes; and external relations); and marketing innovation and its subtypes (i.e., aesthetics and/or packaging; promotion; distribution; and pricing policies). These variables were measured on a nominal scale (Yes/No). Concerning innovation outputs, companies were queried about the number of times they finalized product innovation activities (i.e., goods and services). These variables were ranked on an ordinal scale (1 – "none"; 2 – "1 to 5 times"; 3 – "6 to 10 times"; and 4 – "more than 10 times"). Thirdly, C) perceptions of the evolution between 2010 and 2012 of variables previously reported to characterize firms' internal and external contexts, which were measured on a five-point ordinal scale (1 – strong decrease, to 5 – strong increase). All variables used in this study are listed in the following *Table 1*.

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<sup>5</sup> Within a universe of 4310 ICT services firms, our sample is composed of 87.1% firms with 0 to 9 employees; 5.8% with 10 to 19 employees; 4.2% have 20 to 49 employees; 2.3% with 50 to 250 employees; and 0.6% with more than 250 employees (INE, 2011). In addition, the vast majority of firms in our sample make less than 1 million Euros *per* year (90.1%); 4.3% between 1 and 2 million Euros; 3.3% between 2 and less than 5 million Euros annually; and 2.3% of the firms make 5 or more million Euros annually. Finally, 35.4% of these firms started operating in the period between 2008 and 2012, 46.7% were founded between 2000 and 2007, and 17.9% before 2000.

General Characterization	Innovation activities and outputs	Internal and/or external contexts
1. Classes of number of employees	4. Innovation activities	9. Ev. of financial resources
2. Annual turnover	5. Product innovation	10. Ev. of human resources
3. Date of incorporation	5.1. Goods	11. Ev. of internal bureaucratic structures and procedures
	5.2. Services	12. Ev. of discussion of strategic DM
	6. Process innovation	13. Ev. of management of human resources
	7. Organizational innovation	14. Ev. of knowledge-management <b>(A)</b>
	7.1. Procedures	15. Ev. of planning and monitoring of projects
	7.2. Decision-making processes	16. Ev. of R&D
	7.3. External relations	17. Ev. of creativity stimuli <b>(B)</b>
	8. Marketing innovation	18. Ev. of employees' motivation
	8.1. Aesthetics and/or packaging	19. Ev. of employees' autonomy
	8.2. Promotion	20. Ev. of trust in employees
	8.3. Distribution	21. Ev. of suppliers
	8.4. Pricing policies	22. Ev. of clients
		23. Ev. of competitors
		24. Ev. of networks
		25. Ev. of internationalization <b>(C)</b>
		26. Ev. of external bureaucracy <b>(D)</b>
		27. Ev. of formal internal and external communication <b>(E)</b>
		28. Ev. of pressure on strategic decisions

Note: Ev.: Evolution between 2010 and 2012; DM: decision-making; **(A)** Activities that ease and regulate access to knowledge, e.g., identifying and organizing companies' information and knowledge; supporting the learning of new skills; **(B)** e.g., brainstorming sessions; team work; rotation of employees between departments; multidisciplinary teams and financial and/or non-financial incentives; **(C)** Includes exports; internationalization of human resources; having international partnerships, among others; **(D)** e.g., government regulations; legislation; **(E)** e.g., newsletters; meetings.

**Table 1.** List of variables characterizing ICT services firms

In order to attain the proposed aims, different statistical methods were mobilized. Chi-Square tests were used to evaluate the relation between nominal outcomes. Adjusted standardized residuals were also used to analyse associations between categories of nominal variables. Mann-Whitney tests were computed to test for significant differences in ordinal outcomes between two independent groups.

In order to reduce the number of interrelated measures of variables assessing the evolution of the internal and external contexts between 2010 and 2012 (*Table 1*, third Column), a Principal Component Analysis (PCA) was performed (Carifio & Perla, 2008; Ho, 2006). Subsequently, logistic regressions (Marôco, 2014) were computed to identify the effect of firms' internal and external contexts (assessed through the components resultant from the PCA analysis) on non-technological innovation as well as on its sub-types: organizational and marketing innovation activities. Logistic regressions were further computed to test for the effect of non-technological innovation on the development of innovation outputs and, finally, to evaluate whether non-technological innovation activities mediated the effect of the internal and external contexts on innovation outputs.

All data was analysed with *IBM SPSS Statistics version 20* statistical package.

## Results

### *Characterizing non-technological innovation activities*

Between 2010 and 2012, 71.5% of all ICT services firms operating in Portugal developed innovation activities, and 63.4% specifically developed non-technological innovation activities. In fact, confirming the data reported on the Community Innovation Survey for the period under analysis, these numbers also show a decrease in firms' innovation activities, a decrease that is concomitant to decreases in firms' economic performance between 2010 and 2012 (INE, 2014), i.e., during the socio-economic crisis. Our data is also in line with previous studies reporting the simultaneous presence of both types of innovation activities (Barañano, 2005; Dinis, 2006; European Commission, 2014; Inhan et al., 2013). In fact, the vast majority of firms analysed in our study simultaneously developed technological and non-technological innovation activities (89.8%). These data is reinforced by the statistical analysis showing that firms that develop technological innovation activities have a higher probability of also developing non-technological innovations ( $\chi^2_{(1)} = 204.32$ ;  $p < 0.001$ , and adjusted standardized residual = 14.3;  $|Z| > 1.96$ ; level of confidence of 95%).

In what concerns the specific types of non-technological innovation activities,

53.2% of all firms in our sample developed organizational innovation<sup>6</sup>, and 54.6% presented marketing innovation activities<sup>7</sup>. More importantly, our results further show that firms that developed organizational innovation present a higher probability of also having developed product and process innovation activities (*Table 2*). Finally, firms presenting marketing innovation activities between 2010 and 2012, also have a higher probability of developing product and process innovation activities (*Table 2*).

	$\chi^2_{(1)}$	Adjusted standardized residuals
Organizational vs product innovation	121.45**	11.1
Organizational vs process innovation	121.80**	11.0
Marketing vs product innovation	124.73**	11.2
Marketing vs process innovation	109.42**	10.5

Note: \*\*  $p < 0.001$ ;  $|Z| > 1.96$ ; level of confidence of 95%.

**Table 2.** *Organizational and marketing innovation activities are associated with product and process innovation activities (2010 – 2012).*

Altogether, these data, reinforcing the concomitant presence of technological (product or process) and non-technological innovation activities (organizational or marketing), add specificity to previous studies, indicating the precise types of innovation on which ICT services firms rely upon. Once having established this portray, we will next assess specifically which ICT services companies introduced organizational and marketing innovation activities in the period under analysis.

<sup>6</sup> In what regards the specific sub-types of organizational innovation, 32.1% of all the analysed companies presented innovative organizational procedures, 25.4% innovative decision-making, and 28.1% innovative external relations.

<sup>7</sup> More specifically, between 2010 and 2012, 38.3% of ICT services firms developed innovations on aesthetics/packaging, 30.1% on promotion, 39.9% on distributing, and 30.7% on prices (sub-types of marketing innovation activities).

***ICT services firms developing organizational and marketing innovation activities: from a general characterization to firms' internal and external contexts***

The comparison of firms developing non-technological innovation activities with firms that do not develop these activities shows that these two groups are significantly different in size and annual turnover, but not in what concerns firms' date of incorporation. More specifically, firms developing non-technological innovation activities are larger (Mann-Whitney  $U$  test = 7280.00,  $p < 0.001$ ) and present higher annual turnovers (Mann-Whitney  $U$  test = 7605.00,  $p < 0.001$ ). The same patterns are also present when evaluating companies with organizational and marketing innovation activities *versus* companies that did not introduce these innovative activities between 2010 and 2012<sup>8</sup>. These results, in line with studies above presented (Damanpour, 1992; Nunes, 2012), extend previous studies on organizational and marketing innovation activities, and address, for the first time, ICT services firms operating in Portugal between 2010 and 2012, i.e., during the socio-economic crisis.

Following this general characterization of firms, we evaluated whether the evolution of indicators of the internal and external contexts were significantly different among firms with and without organizational and marketing innovation activities. Building upon previous studies addressing the impact of the individual sub-dimensions of the organizational contexts on non-technological innovation development and our own data<sup>9</sup>, we will now address the concomitant role of these variables in the development of non-technological innovation activities in general, as well as their role in organizational and marketing innovation activities.

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<sup>8</sup> Firms with organizational and marketing innovation activities are larger (Mann-Whitney  $U$  test = 7520.00,  $p < 0.001$ , Mann-Whitney  $U$  test = 8441.00,  $p < 0.001$ , respectively) and present higher annual turnovers (Mann-Whitney  $U$  test = 7746.00,  $p < 0.001$ ; Mann-Whitney  $U$  test = 8606.50,  $p < 0.001$ , respectively).

<sup>9</sup> The comparison of the individual sub-dimensions of the internal and external organizational contexts (*Table 1*, third column, variables 9 to 28) among firms with and without non-technological innovation activities shows that with the exception of indicators evaluating the evolution of internal and external bureaucratic processes, as well as the ones focusing on suppliers and competitors, all other sub-dimensions present significant differences among firms (Mann-Whitney tests, differences are significant at the 95% level). More specifically, firms that developed non-technological innovations present a more positive evolution of these indicators between 2010 and 2012 (increased mean ranks), suggesting more favourable internal and external contexts than the contexts of firms that did not develop organizational and/or marketing innovation activities.

For this purpose, we first carried out a Principal Component Analysis (PCA) with the variables assessing firms' internal and external contexts<sup>10</sup> (*Table 1*, third column, variables 9 to 28). This procedure aimed at reducing data's complexity (Carifio & Perla, 2008; Ho, 2006). Five components were extracted accounting for 63.9% of the variance (Kaiser criterion). The factor loadings, resulting from a Varimax rotation, are presented in *Table 3*.

	Factor loadings	% of Variance explained
<b>Research and empowerment</b>		35.64
Employees' motivation	0.87	
Employees' autonomy	0.84	
Trust in employees	0.83	
Creativity stimuli	0.72	
Planning and monitoring	0.56	
R&D	0.52	
Management of knowledge	0.52	
<b>Assets</b>		9.08
Human resources	0.75	
Financial resources	0.71	
Clients	0.68	
Management of human resources	0.68	
Formal communication	0.59	
Internationalization	0.59	
Networks	0.43	
<b>Contexts of Decision-making (cDM)</b>		7.86
Pressure on decision-making	0.88	
Discussion of decision-making	0.77	
<b>Bureaucracy</b>		5.90
Internal bureaucratic structures and procedures	0.81	
External bureaucracy	0.81	
<b>Competitors</b>		5.46
Competitors	0.92	
Suppliers	0.41	

Note: Input variables in grey (networks and suppliers), having a much smaller contribution for the corresponding component (factor loadings below 0.50), could be disregarded in the analysis.

**Table 3.** *ICT services firms' activities are described by Research and empowerment; Assets; contexts of Decision-making; Bureaucracy and Competitors.*

<sup>10</sup> KMO = 0.87; Bartlett's test of sphericity:  $\chi^2_{(190)} = 1047.62, p < 0.001$ .



The first component, “*Research & empowerment*”, combines variables that evaluate differential paths of empowering companies’ employees with variables related to knowledge management and creation. “*Assets*” groups internal organizational resources with external resources. “*Contexts of Decision-making*” (cDM) aggregates the discussion of and pressure in strategic decision-making, thus addressing the structure and climate of strategic decision-making in ICT services firms. “*Bureaucracy*” groups the evolution of internal bureaucratic structures and procedures and external bureaucracy. The last extracted factor mainly includes the contribution of the variable “*Competitors*” with “*Suppliers*” having a much smaller, negligible contribution.

Having established these components, we next explored their role on the development of non-technological, organizational, and marketing innovation activities between 2010 and 2012 (*Tables 4, 5 and 6, respectively*).

Model 1 – Non-technological innovation							
Variables	B	Std. error	$\chi^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Research & empowerment	1.49	0.30	25.35	1	0.000	4.45	]2.49; 7.96[
Assets	1.02	0.28	13.65	1	0.000	2.77	]1.61; 4.76[
cDM	1.60	0.32	25.37	1	0.000	4.94	]2.65; 9.19[
Bureaucracy	-0.18	0.26	0.51	1	0.476	0.83	]0.51; 1.37[
Competitors	-0.13	0.24	0.29	1	0.588	0.88	]0.55; 1.4[
Constant	1.72	0.29	34.81	1	0.000	5.58	
Model Statistics							
Model Fit	$G^2(5) = 75.85; p < 0.001$						
	$\chi^2_{HL}(8) = 9.30; p = 0.318$						
$R^2_N^{11}$	0.508						
Correctly predicted	83.2%						
Note: cDM: contexts of strategic decision-making; $\chi^2_{HL}$ : Hosmer and Lemeshow test; $R^2_N$ : $R^2$ Nagelkerke.							

**Table 4.** *Logistic regression model of non-technological innovation activities (2010 – 2012)*

<sup>11</sup>  $R^2$  in logistic regressions tend to be smaller than  $R^2$  in linear regressions. Their evaluation needs to take into consideration that low  $R^2$  values in logistic regression are the norm (Hosmer, Lemeshow, & Sturdivant, 2013).

The adjusted logistic regression of the development of non-technological innovation activities as a function of Research & empowerment; Assets; contexts of Decision-making; Bureaucracy; and Competitors (*Table 4*, Model 1) is significant ( $G^2(5) = 75.85$ ;  $p < 0.001$ ). Additionally, and in line with previous studies mostly addressing the disaggregated contributions of these variables (Cohn & Turyn, 1984; Daft, 1978; Damanpour, 1987, 1991; Lind & Zmud, 1991; Moreira et al., 2012; Rogers, 2010; Wan et al., 2005), our data shows that the development of non-technological innovation activities is directly dependent on Research & empowerment; Assets; and contexts of Decision-making. Companies developing non-technological innovation activities have a higher probability of presenting increasing research activities and mobilization of empowerment strategies; increasing internal and external assets; increasing discussion of strategic decision-making processes (which corresponds to less centralized decision-making processes); and increasing pressure on strategic decision-making (probably associated with the high uncertainty levels that characterize the development and implementation of innovation activities).

Focusing now on the two sub-types of non-technological innovation activities, our results show that the adjusted logistic regressions of the development of organizational and marketing innovation activities (*Tables 5* and *6*, Models 2 and 3) are statistically significant. Additionally, our data reveal that both the development of organizational and marketing innovation activities are dependent on Research & empowerment; Assets; and contexts of Decision-making, with companies with both types of innovation having a higher probability of presenting a positive evolution of the predictors.

Altogether, this data confirms our *hypothesis 1* stating that between 2010 and 2012, the development of non-technological innovation activities by ICT services firms operating in Portugal between 2010 and 2012 is simultaneously dependent on firms' intra- and extra-organizational contexts.

Model 2 – Organizational innovation							
Variables	B	Std. error	$\chi^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Research & empowerment	1.35	0.25	28.44	1	0.000	3.86	]2.35; 6.34[
Assets	1.11	0.24	20.80	1	0.000	3.03	]1.88; 4.87[
cDM	1.26	0.26	24.49	1	0.000	3.53	]2.14; 5.83[
Bureaucracy	0.05	0.22	0.06	1	0.815	1.05	]0.69; 1.60[
Competitors	-0.04	0.21	0.04	1	0.847	0.96	]0.64; 1.44[
Constant	0.67	0.21	10.65	1	0.001	1.96	
<b>Model Statistics</b>							
Model Fit	$G^2(5) = 78.16; p < 0.001$						
	$\chi^2_{H-L}(8) = 6.15; p = 0.630$						
$R^2_N$	0.484						
Correctly predicted	79.8%						

Note: cDM: contexts of strategic decision-making;  $\chi^2_{H-L}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Table 5.** Logistic regression model of organizational innovation activities (2010 – 2012).

<b>Model 3 – Marketing innovation</b>							
<b>Variables</b>	<b>B</b>	<b>Std. error</b>	<b><math>\chi^2_{Wald}</math></b>	<b>df</b>	<b>p-value</b>	<b>Exp(B)</b>	<b>95% Confidence Interval</b>
Research & empowerment	1.35	0.25	28.67	1	0.000	3.84	]2.35; 6.28[
Assets	0.65	0.22	8.81	1	0.003	1.92	]1.25; 2.94[
cDM	1.20	0.25	22.73	1	0.000	3.33	]2.03; 5.46[
Bureaucracy	0.13	0.21	0.34	1	0.559	1.13	]0.75; 1.72[
Competitors	0.09	0.21	0.21	1	0.648	1.10	]0.73; 1.65[
Constant	0.95	0.21	20.41	1	0.000	2.59	
<b>Model Statistics</b>							
Model Fit	$G^2(5) = 65.36; p < 0.001$						
	$\chi^2_{HL}(8) = 8.58; p = 0.379$						
$R^2_N$	0.426						
Correctly predicted	80.4%						

Note: cDM: contexts of strategic decision-making;  $\chi^2_{HL}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Table 6.** Logistic regression model of marketing innovation activities (2010 – 2012).

Having established a detailed characterization of non-technological innovative ICT services firms, we will next check whether the presence of these activities is associated with innovation outputs, namely, goods and services.

### ***The impacts of non-technological innovation activities on technological innovation outputs***

To address whether the development of goods and services were dependent on firms presenting non-technological innovation activities, we performed logistic regression analyses.

In what concerns the development of goods, our results indicated that the adjusted regression model is significant ( $G^2(1) = 90.84; p < 0.001$ )

(Appendix 1: *Supplementary Table 1*, Model 4). The data additionally showed that firms with non-technological innovation activities present a higher probability of producing innovative goods than companies without these activities. In the reverse situation, i.e., firms without non-technological innovation activities, a higher probability of not producing innovative goods is present.

Regarding the development of innovative services, our results indicated that the adjusted regression model is significant ( $G^2(1) = 175.61$ ;  $p < 0.001$ ) (Appendix 1: *Supplementary Table 2*, Model 5). As for the development of goods, firms with (without) non-technological innovation activities present a higher probability of (not) producing innovative services. These data, pointing to the potential impact of non-technological innovation activities in diverse innovation outputs (goods; services), confirm the results of Makkonen and colleagues, who showed a positive significant relation between organizational innovation and product innovation outputs during the global financial crisis (Makkonen et al., 2014)<sup>12</sup>. Our results, extending these findings to the Portuguese socio-economic crisis context, confirm our *hypothesis 2* and reveal that the development of technological innovation outputs (i.e., goods and services) is dependent on non-technological innovation activities.

In summary, we have shown that 1) Research & empowerment; Assets; and contexts of Decision-making impact on non-technological innovation activities, and that 2) non-technological innovation activities impact on technological innovation outputs. Having established these relations, we will now assess whether non-technological innovation activities mediate the relation between the internal and external organizational contexts and innovation outputs.

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<sup>12</sup> Logistic regression models of technological innovation outputs (i.e., goods and services) as a function of organizational innovation activities and marketing innovation activities are significant and present very similar results with predictor and outcome variables changing in the same direction (unpublished data).

***Non-technological innovation activities mediate the impacts of the internal and external contexts on innovation outputs***

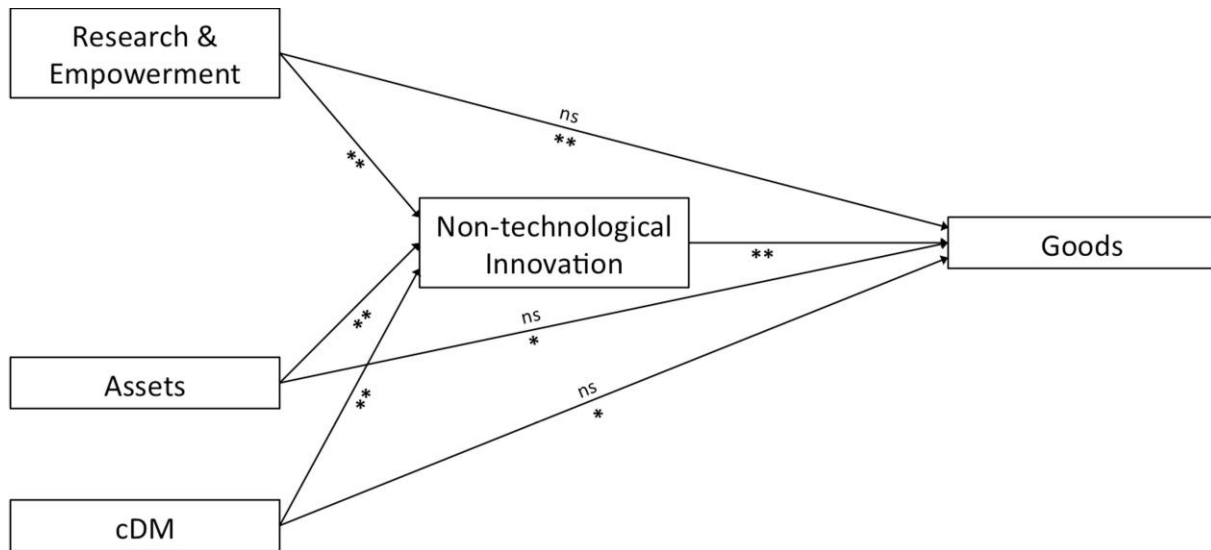
In order to assess whether non-technological innovation activities mediate the impacts of the internal and external organizational contexts on innovation outputs, we first addressed whether the development of these outputs (goods and services) were dependent on the predictor variables: Research & empowerment; Assets; and contexts of Decision-making<sup>13</sup>.

Focusing first on the development of goods, our logistic regression model is significant ( $G^2(3) = 18.80$ ;  $p < 0.001$ ) (Appendix 1: *Supplementary Table 3*, Model 6). Moreover, our results indicate that both predictors and outcome variables change in the same direction, with increases in the predictors being associated with the development of innovative goods. Also, decreases in the predictors are associated with the absence of innovative goods.

Next, we assessed the mediation model. As such, to test whether non-technological activities were significantly mediating the impacts of the intra- and extra-organizational contexts on the production of innovative goods a bootstrapping procedure was used (Preacher & Hayes, 2008). Our results indicate that the logistic regression model is significant ( $G^2(4) = 47.804$ ;  $p < 0.001$ ) (Appendix 1: *Supplementary Table 4*, Model 7). This analysis revealed that the relationship between predictors and outcome was significantly and totally mediated by non-technological innovation activities (Appendix 1: *Supplementary Table 4*, Model 7). Hence, the impact of Research & empowerment; Assets; and contexts of Decision-making on the production of innovative goods occurs entirely through the development of non-technological innovation activities (*Figure 1*).

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<sup>13</sup> Only the variables Research & empowerment; Assets; and contexts of Decision-making predict the development of our potential mediator, i.e., non-technological innovation activities, and thus, were the only ones considered in the following regression models.



All regression coefficients indicate direct relations among variables (i.e., with both predictors and outcome variables changing in the same direction). The results of statistical significance tests indicated below each path represent direct effects between variables when the mediator is absent from the model. The results of statistical significance tests indicated above each path represent the effects when the mediator is included in the model.

\* $p < 0.01$ ;

\*\* $p < 0.001$ ;

ns: non-significant;

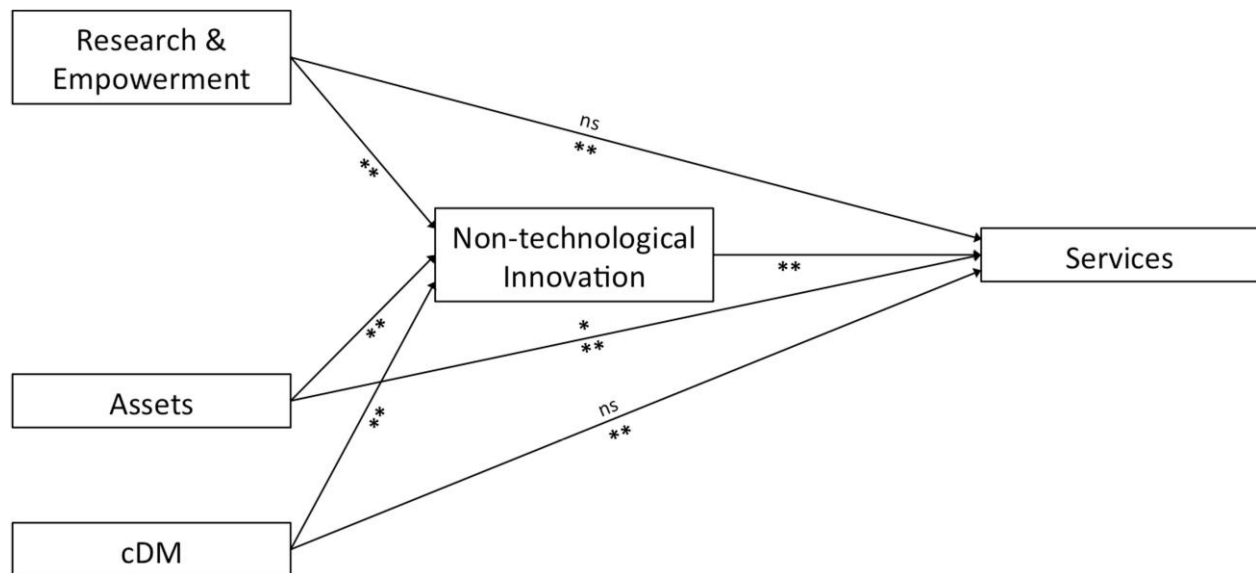
cDM: contexts of Decision-making.

**Figure 1.** Path diagram of the relations between Research & empowerment; Assets; and contexts of Decision-making; and innovative goods mediated by non-technological innovation.

The evaluation of the dependency relation between the production of innovative services and the internal and external organizational contexts reveals a significant relation ( $G^2(3) = 52.66$ ;  $p < 0.001$ ) (Appendix 1: *Supplementary Table 5*, Model 8). As for the earlier presented models, both predictors and outcome variables change in the same direction.

A mediation model addressing the effect of non-technological innovation activities on the relation between Research & empowerment; Assets; and contexts of Decision-making, and the production of innovative services was then computed. Following Preacher and Hayes (Preacher & Hayes, 2008), a bootstrapping procedure was used, resulting in a significant model ( $G^2(4) = 92.495$ ;  $p < 0.001$ ) (Appendix 1: *Supplementary Table 6*, Model 9). As such, non-technological innovation activities are significantly mediating the impacts

of the intra- and extra-organizational contexts on the production of innovative services (Figure 2). Moreover, our data revealed that the relationship between predictors and outcome is partly mediated by non-technological innovation activities. This is case since the impact of Assets on innovative services is still significant in the presence of the mediator (Appendix 1: *Supplementary Table 6, Model 9*).



All regression coefficients indicate direct relations among variables (i.e., with both predictors and outcome variables changing in the same direction). The results of statistical significance tests indicated below each path represent direct effects between variables when the mediator is absent from the model. The results of statistical significance tests indicated above each path represent the effects when the mediator is included in the model

\* $p < 0.01$ ;

\*\* $p < 0.001$ ;

ns: non-significant.

cDM: contexts of Decision-making.

**Figure 2.** Path diagram of the relations between Research & empowerment; Assets; and contexts of Decision-making; and innovative services mediated by non-technological innovation.



Altogether these results confirm our *hypothesis 3*, i.e., that between 2010 and 2012, non-technological innovation activities mediate the impact of firms' intra- and extra-organizational contexts on the production of both goods (*Figure 1*; Appendix 1: *Supplementary Table 4*, Model 7) and services (*Figure 2*; Appendix 1: *Supplementary Table 6*, Model 9).

## Discussion

### ***Linking non-technological innovation activities to technological outputs***

This study shows that non-technological innovation activities mediate the impacts of Research & empowerment; Assets; and contexts of Decision-making on technological innovation outputs. Most importantly, the production of innovative goods and services has an increased probability of not occurring upon unfavourable evolution of the above-mentioned variables and in the absence of organizational and/or marketing activities. In a context severely marked by the socio-economic crisis, the fact that ICT services firms present decreased innovative performance (European Commission, 2014) can be partly explained by our results. According to our data, these are the companies with decreasing research activities, decreased mobilization of empowerment strategies, decreased assets (financial and human resources; clients; management of human resources; communication; and internationalization), increased centralization of decision-making processes (decreased discussion of strategic decision-making), and perceiving lower pressure on strategic decision-making than the companies that carry out innovation processes. These results pinpoint, for the first time, the intra- and extra-organizational foundations of innovation in ICT services firms operating under the socio-economic crisis in Portugal.

Additionally, these contextual impacts are mediated via the development of non-technological innovation activities. This implies that for the fewer companies which are still developing innovative goods and services (corresponding to approximately two thirds of all firms in our sample), the

presence of non-technological innovation activities is critical for the release of innovation outputs to the markets. Since these outputs were many times associated with firms' economic performance, and since in the period of time this paper addresses, ICT services firms decreased both innovative and economic performances (INE, 2014), developing non-technological activities becomes even more important. This is precisely the major contribution of this paper: non-technological innovation activities mediate the framing of the intra- and extra-organizational contexts on innovation outputs. Innovation can thus be seen as a contextually-framed change process in which the relation between releasing goods or services to the markets and the intra- and extra-organizational contexts where those products/services are developed, is mediated by the development of new marketing practices and/or new procedures regarding business practices; workplace organization and/or external relations. This implies that as important as firms' internal and external organizational layers, and particularly companies' financial resources and clients (Ferreira, 2016; Ferreira & Teixeira, 2016), companies that are technologically innovative are required to embrace new organizational and marketing procedures. As such, this study contributes to the literature on innovation during the global financial crisis since we add an additional layer to previous analysis showing that firms with non-technological innovation could better cope with the crisis challenging economic scenario. More specifically, the current study pinpoints the mediator role of non-technological innovation on innovation outputs.

Moreover, these results have practical implications. Our data reveals that simply operating under favourable intra- and extra-organizational contexts does not suffice for getting innovation outputs to the markets. It is critical that companies also develop non-technological innovation activities. Only the full combination of these variables can create the virtuous organizational environment that favours the full cycle of innovation: from the initial idea, to its development, to its release as a good or service in the markets. At the firm level, managers cannot disregard this information, and should strongly favour the combined development of technological and non-technological innovation activities. At a broader level, and as previously suggested by Izsak and colleagues based on the positive impacts of non-technological innovation activities on firms' productivity, efficiency, and effectiveness (Izsak, Markianidou, Lukach, & Wastyn, 2013), this study also suggests that public policies aiming at innovation development, in addition to promoting directly the development of technological innovation, should specifically target organizational and marketing innovation activities.

### ***Limitations and future studies***

One limitation of the present study is that it focuses on one single sector of economic activities of one single country. This implies that our results and conclusions need to be taken with caution as to their application to other sectors and countries. In the future, it would be interesting to extend this characterization to other economic sectors, evaluating the impacts of non-technological innovation on both innovative and economic performance.

Another limitation of our study results from exploring innovation processes as a whole, which precludes us from addressing the similitude and differences of the different overlapping sub-stages of innovation development (Pavitt, 2006). This lacuna will be the focus of a future qualitative characterization of innovation processes as they develop.

In addition, since we are restricting our study to a specific time period, one that is characterized by a socio-economic crisis with severe impacts on firms' innovative and economic performance, these results, despite giving us original inputs into the development of innovation processes during the socio-economic crisis, would gain from a direct comparison with time periods in which the socio-economic crisis is absent.

One final limitation results from characterizing innovation processes strictly from a top managers' perspective. A study encompassing the perspective of companies' employees would provide a more comprehensive outlook into firms' activities. These limitations do not however jeopardize the significance of this study for a first scientific characterization of non-technological innovation activities and their central role on innovation performance at the ICT services sector.

### ***Concluding remarks***

This paper shows the critical relevance of non-technological innovation activities for the production of innovation outputs. Most importantly, it reveals that the decreasing pattern of innovative performance during the socio-economic crisis could be attributed not only to unfavourable firm and environmental contexts, but also to the absence of non-technological innovation activities. As such, this study suggests that support of non-technological innovation by firms' managers, and at a broader level, by public policies, is of the utmost importance for the launching of innovative goods and services.

## Appendix 1. Supplementary Data

Model 4 – Innovation outputs: Goods							
Variables	B	Std. error	$X^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Non-technological innovation	2.82	0.36	62.29	1	0.000	16.76	]8.32; 33.76[
Constant	-2.14	0.32	44.84	1	0.000	0.12	
Model Statistics							
Model Fit	$G^2(1) = 90.84; p<0.001$						
$R^2_N$	0.374						
Correctly predicted	75.1%						

Note: cDM: contexts of strategic decision-making;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 1.** Logistic regression model of the development of goods (2010 – 2012).

Model 5 – Innovation outputs: Services							
Variables	B	Std. error	$X^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Non-technological innovation	4.05	0.38	111.69	1	0.000	57.47	]27.11; 121.84[
Constant	-1.95	0.30	43.07	1	0.000	0.14	
<b>Model Statistics</b>							
Model Fit	$G^2(1) = 175.61; p<0.001$						
R <sup>2</sup> <sub>N</sub>	0.633						
Correctly predicted	88.5%						

Note: cDM: contexts of strategic decision-making;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 2.** Logistic regression model of the development of services (2010 – 2012).

## Enterprise and Work Innovation Studies

Model 6 – Innovation outputs: Goods							
Variables	B	Std. error	$\chi^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Research & empowerment	0.56	0.18	10.22	1	0.001	1.75	]1.24; 2.48[
Assets	0.41	0.17	5.74	1	0.017	1.51	]1.08; 2.11[
cDM	0.35	0.18	3.87	1	0.049	1.42	]1.00; 2.00[
Constant	0.05	0.16	0.11	1	0.737	1.06	
<b>Model Statistics</b>							
Model Fit	$G^2(3) = 18.795; p < 0.001$						
	$\chi^2_{HL}(8) = 2.875; p = 0.942$						
$R^2_N$	0.135						
Correctly predicted	65.9%						

Note: cDM: contexts of strategic decision-making;  $\chi^2_{HL}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 3.** Logistic regression model of the development of goods (2010 – 2012).

Model 7 – Mediation Model, Outputs: Goods					
Variables	B	Bootstrap <sup>a</sup>			
		Bias	Std. Error	Sig. (2-tailed)	95% Confidence Interval
Research and empowerment	0.17	0.03	0.22	0.426	] -0.24; 0.68[
Assets	0.16	0.01	0.19	0.381	] -0.20; 0.56[
cDM	-0.09	-0.01	0.23	0.664	] -0.56; 0.34[
Non-technological innovation	2.67	0.35	2.10	0.001	] 1.64; 4.63[
Constant	-2.02	-0.34	2.08	0.001	] -3.94; -1.140[
<b>Model Statistics</b>					
Model Fit	$G^2(4) = 47.8; p < 0.001$				
	$\chi^2_{HL}(8) = 7.14; p = 0.522$				
$R^2_N$	0.320				
Correctly predicted	71.8%				

Note: a: Bootstrap results are based on 1000 bootstrap samples; cDM: contexts of strategic decision-making;  $\chi^2_{HL}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 4.** Logistic regression model of the development of goods (2010 – 2012) (indirect effects).

## Enterprise and Work Innovation Studies

Model 8 – Innovation outputs: Services							
Variables	B	Std. error	$\chi^2_{Wald}$	df	p-value	Exp(B)	95% Confidence Interval
Research & empowerment	0.97	0.23	18.00	1	0.000	2.63	]1.68; 4.10[
Assets	0.95	0.24	16.12	1	0.000	2.59	]1.63; 4.11[
cDM	1.07	0.25	18.40	1	0.000	2.92	]1.79; 4.76[
Constant	1.20	0.22	30.16	1	0.000	3.30	
<b>Model Statistics</b>							
Model Fit	$G^2(3) = 52.66; p < 0.001$						
	$\chi^2_{HL}(8) = 6.75; p = 0.564$						
$R^2_N$	0.367						
Correctly predicted	80.3%						

Note: cDM: contexts of strategic decision-making;  $\chi^2_{HL}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 5.** *Logistic regression model of the development of services (2010 – 2012).*

Model 9 – Mediation Model, Outputs: Services					
Variables	B	Bias	Std. Error	Bootstrap <sup>a</sup>	95% Confidence Interval
				Sig. (2-tailed)	
Research and empowerment	0.37	0.03	0.32	0.189	] -0.21; 1.09[
Assets	0.67	0.05	0.30	0.012	] 0.19; 1.34[
cDM	0.47	0.03	0.32	0.096	] -0.09; 1.15[
Non-technological innovation	3.10	0.18	0.64	0.001	] 2.13; 4.61[
Constant	-0.99	-0.05	0.51	0.026	] -2.09; -0.11[
<b>Model Statistics</b>					
Model Fit	$G^2(4) = 92.50; p < 0.001$				
	$\chi^2_{HL}(8) = 8.36; p = 0.399$				
$R^2_N$	0.584				
Correctly predicted	88.1%				

Note: a: Bootstrap results are based on 1000 bootstrap samples; cDM: contexts of strategic decision-making;  $\chi^2_{HL}$ : Hosmer and Lemeshow test;  $R^2_N$ :  $R^2$  Nagelkerke.

**Supplementary Table 6.** *Logistic regression model predicting the development of services (2010 – 2012) (indirect effects).*

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